Sludge Washing

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

Vitrifying waste and pouring the molten glass into canisters is the preferred method for immobilizing tank sludges.

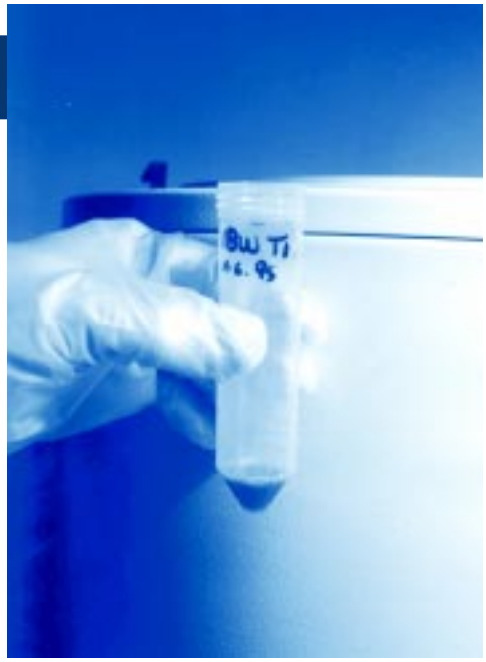
Problem

Approximately 340 million liters of highly radioactive wastes from weapons production activities are stored in underground storage tanks on Department of Energy (DOE) sites. Removing underground storage tanks from service requires that tank wastes be removed, immobilized, and prepared for permanent disposal. A large percentage of tank wastes include sludges with various chemical and physical properties that have collected at the bottom of the tank over time.

DOE's preferred method for safely immobilizing tank sludges is vitrification. Vitrification is a process that melts radioactive waste with glass-forming materials that solidify into glass after cooling. Certain chemicals and elements in the tank sludges can negatively affect the vitrification process and add to the volume of highly radioactive glass, increasing the costs for waste treatment and disposal.

Solution

With Sludge Washing (OST/TMS ID 233), water or dilute hydroxide solution is used to remove soluble nonradioactive components from the tank sludges that increase the glass volume. Enhanced Sludge Washing differs from "simple" Sludge Washing in that a concentrated hydroxide solution — or caustic — is used instead of water in the initial washing process. The caustic dissolves large quantities of certain nonradioactive elements in the sludges that increase glass volume, such as aluminum, chromium and phosphorus. With both processes, the wash liquid is decanted, further treated to reduce the concentration of radionuclides, immobilized as low-activity waste, and sent to on-site disposal. Most of the radionuclides remain in the sludges, which are vitrified and prepared for off-site disposal in a geologic repository.



The Tanks Focus Area with partners from Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National laboratories, conducted various tests using Enhanced Sludge Washing. The tests determined how tank wastes responds chemically and physically during Enhanced Sludge Washing so that DOE Sites select the best processing conditions.

Benefits

- Sludge Washing reduces the volume of glass produced when vitrifying highly radioactive wastes. Costs per unit volume for vitrifying and disposing of highly radioactive wastes are much greater than those for treating and disposing of less radioactive wastes
- Enhanced Sludge Washing removes more of the unwanted, nonradioactive components from tank sludges than simple Sludge Washing

Sludge Washing IS improved by various processes...

Effectiveness of Enhanced Sludge Washing for Treating Hanford Tank Waste

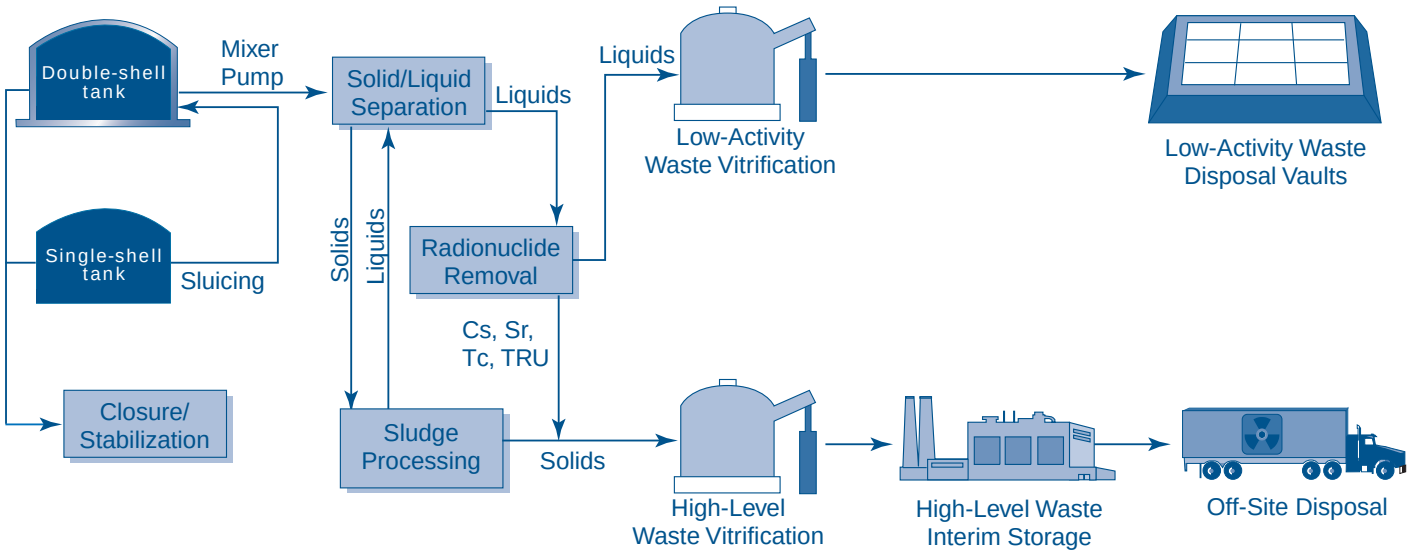
Enhanced Sludge Washing was selected to pretreat tank sludges at the Hanford Site (Washington). A Hanford Federal Facility Agreement and Consent Order Milestone (M-50-03) required determining the volume of highly radioactive glass prepared for disposal at the geologic repository.

The Tanks Focus Area performed tests on sludge samples so that process engineers could develop full-scale process flow sheets for Hanford waste types. In a March 1998 decision, DOE determined that Enhanced Sludge Washing for pretreatment of Hanford tank sludges would produce an acceptable number of glass canisters.

There are an estimated 25 different types of sludge at the Hanford Site distributed among 177 tanks.

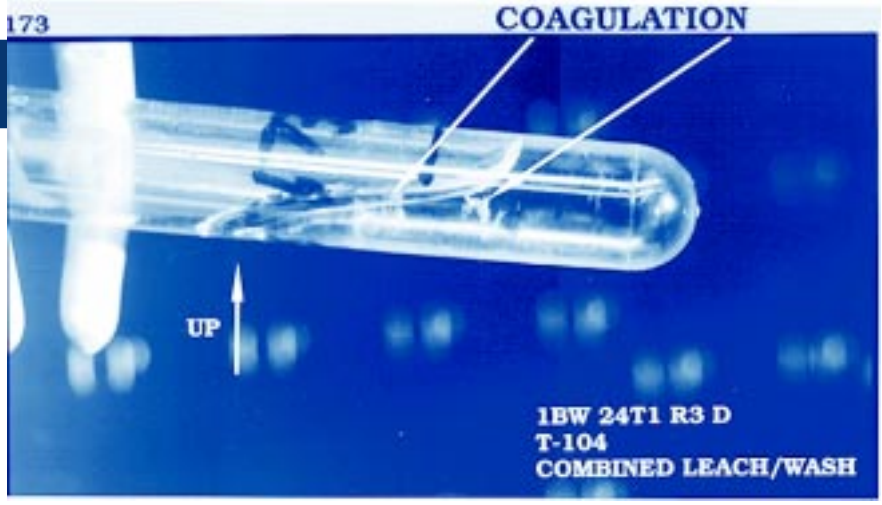
Benefits:

- Enhanced Sludge Washing reduces by 60% the volume of Hanford tank sludges requiring expensive treatment and off-site disposal
- An estimated cost avoidance of $4.8 billion is included in the Hanford baseline from Enhanced Sludge Washing



Solids will be separated from liquids after retrieval of Hanford's tank sludges. Liquids from solid/liquid separation will be processed to reduce the concentration of radionuclides and sent for low-activity waste immobilization and on-site disposal. Solids from solid/liquid separation will undergo sludge processing, high-level waste vitrification, and off-site disposal.

Control of Solids Formation



Coagulants float in a laboratory sample from Hanford Tank T-104 after a laboratory leaching/washing procedure.

Some sludges form insoluble compounds during Enhanced Sludge Washing unless proper operating conditions are maintained. These insoluble compounds can plug pipes during transfer of washed sludges and interfere with pumps, filters, and other process equipment.

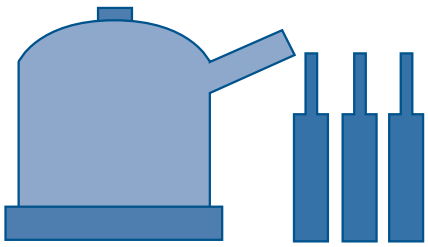
The Tanks Focus Area and its partner programs conducted tests with Hanford tank sludge to determine the operating range for effectively leaching and washing the sludge without causing solids to form in processing solutions. Experimental results and computer model calculations showed that temperature and solution concentrations are significant factors. In solutions containing phosphate and fluoride, solids formation was harder to control at lower temperatures and higher hydroxide concentrations. Another experiment showed that adding lime (calcium oxide) to the sludge reduced gel formation.

Benefits:

- Helps prevent the chemical reactions that can form pipeline plugs
- Avoids costly downtime to remove pipeline blockages

Chromium Removal

The Tanks Focus Area conducted tests to improve the performance of Enhanced Sludge Washing for removing chromium. Chromium is considered the most important constituent in defining the total volume of highly radioactive glass to be produced from the Hanford tank sludges. The presence of chromium greatly complicates the vitrification process by forming a second phase in the melter that affects glass quality and short circuits the melter electrodes. Oxidizers, such as elemental oxygen and permanganate, increase the solubility of chromium to more effectively wash it from the sludge. As much as 99% of the chromium was removed during testing.



Chromium contributes significantly to the melter damage and the volume of glass sent to a geologic repository.

Benefits:

- Significantly reduces the volume of highly radioactive glass produced from selected Hanford tank sludges
- Improves the efficiency and reliability of melter operations

Dissolution Behavior of Melton Valley Storage Tank Sludges

The Tanks Focus Area conducted dissolution tests using sludge from Melton Valley Storage Tanks at the Oak Ridge Reservation (Tennessee). Results helped the site evaluate processing options. The studies of the dissolution behavior of tank sludges determined that the solubility of unwanted components was increased by caustic leaching at elevated temperatures. Acidic treatment of sludges was found to be problematic because of gel formation in the leachates.

Benefits:

- Aided in the development of a comprehensive sludge processing flowsheet
- Facilitated development of plans for privatized treatment of tank waste at Oak Ridge Reservation

Sludge was collected from the Melton Valley Storage Tanks and then transferred into hot cells for testing and process development.

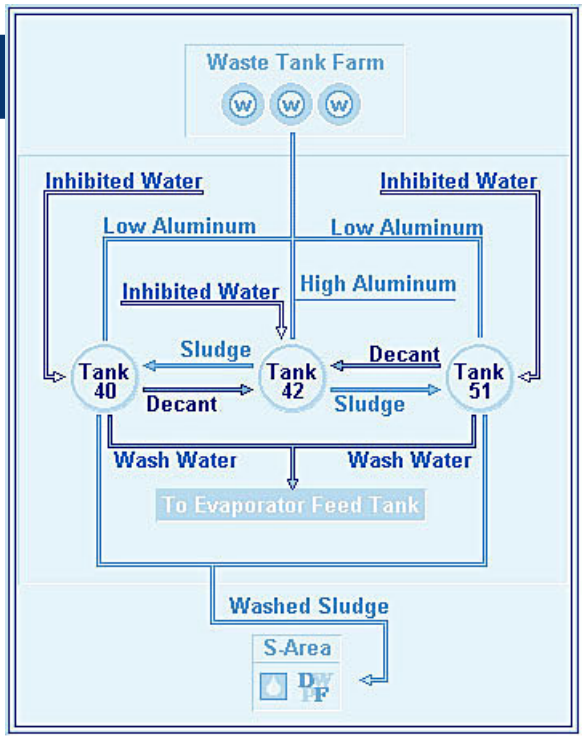
Forty tanks hold the bulk of the past and current liquid waste at Oak Ridge Reservation.

Sludge Washing Tests at Savannah River Site

The Tanks Focus Area used waste samples retrieved from Savannah River Site (South Carolina) tanks to evaluate alternative approaches to washing sludges at DOE sites. A conceptual flow sheet was developed for a continuous process that uses a series of tanks to wash sludges in a cascade such that sludge and wash water flow in opposite directions.

Benefit:

- Continuous Sludge Washing decreases the amount of wash water required, reducing liquid waste treatment costs



At Savannah River Site, 51 carbon steel tanks contain 125 million liters of waste. Savannah River Site has already initiated Sludge Washing. Sludge Washing involves batchwise mixing, settling, and decanting within underground storage tanks.

For more information

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